1956.

STORY OF *ancient life*

By MADELEINE A. FRITZ

ROYAL ONTARIO MUSEUM, TORONTO

Louise Seale

Story of Ancient Life

SHOWING DIVISIONS OF GEOLOGICAL TIME DEVELOPMENT OF PLANT AND ANIMAL LIFE

ERA	PERIOD	ROCKS	DOMINANT LIFE		
CENOZOIC 50,000,000 Years	TERTIARY		AGE of MAMMALS		PLANTS
MESOZOIC 150,000,000 Years	CRETACEOUS		AGE of AMMONITES	AGE of SEED	MODERN
	JURASSIC		AGE of REPTILES and		PLANTS
	TRIASSIC			AGE of SEED	ANCIENT
PALAEOZOIC 350,000,000 Years	PERMIAN		AGE of AMPHIBIANS		
	CARBONIFEROUS			AGE of BEARING	PLANTS
	DEVONIAN		AGE of FISHES and CORALS	SPORE	
	SILURIAN				
	ORDOVICIAN		AGE of INVERTEBRATES		SEA-WEEDS
	CAMBRIAN				
PROTEROZOIC 900,000,000 Years	PRECAMBRIAN		RISE of INVERTEBRATES	AGE of	
ARCHAEOZOIC 500,000,000 Years					

STORY OF

Ancient Life

By

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ROYAL ONTARIO MUSEUM, TORONTO, 1956

Published by Authority of the Museum Board
Royal Ontario Museum
Toronto, Canada

Printed by
University of Toronto Press

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Story of Ancient Life

How the History of the Past Is Read

To many of us, ancient history begins when records of some kind were made that could be read or otherwise interpreted by people of the present day. In the popular sense this idea is correct. It is true that we can read the history of ancient Greece and Rome; furthermore, it is possible to interpret the strange characters left to succeeding generations by still older human civilizations that are being unearthed from time to time. Nevertheless, even the oldest of these civilizations dates back only a few thousand years, and, while they may seem ancient according to our standard of reckoning, they appear but as yesterday on the calendar of Mother Nature.

Long before man appeared on the earth, race after race of primitive creatures inhabited the seas and lands in an orderly succession. These races handed down no inscribed records to posterity but the remains, chiefly of their hard parts, which are entombed in certain rocks as *fossils* serve as documents to reveal much of the history of the age in which each lived. Such ancient history as this is dealt with in the branch of science known as *Palaeontology*, which in simple language means 'the story of ancient life.'

In this booklet an attempt will be made to trace through the ages, by means of the fossil record, the vast procession of life

which started countless millenniums ago with the primitive organisms, and which is still marching on to-day, composed at present of the living things with which we are now familiar.

When the Earth Began

It will no doubt seem strange to some who read these pages to learn that in the beginning the earth was, in all likelihood, a lifeless planet. Many theories have been advanced to account for the formation of our planet. According to one theory, known as the tidal-gaseous or sunbolt hypothesis put forward by Jeffries and Jeans, the earth 3,000 million years (or more) ago was a tremendously hot gaseous mass which revolved about the sun from which it had been originally expelled. So high were the temperatures that no form of life, however primitive, could possibly live therein. As time went on, cooling took place and a crust gradually formed from the combination of elements that existed in the primordial mass. When the crust of the globe cooled sufficiently so that water falling upon it was not returned as vapour to the outer regions but, instead, remained in crustal depressions, then the primary oceans formed. This event dated back over 2,000 million years. The series of murals in the galleries of invertebrate palaeontology of the Royal Ontario Museum is based upon the above assumption.

Another theory which is at present gaining acceptance postulates that originally cosmic dust pervaded all space. Certain concentrations of this dust were affected by mutual gravitational attraction of all the particles towards each other and hence towards a centre. In each concentration the resulting compaction of the particles caused increasing temperatures. Finally, the temperature was high enough to bring about fusion in the accumulated mass. Thus a molten body resulted which, in our particular case, we call the earth. Lincoln Barrett in his story "The Earth is Born"[1] visu-

[1] *Life Magazine*, December 8, 1952.

alizes the evolution as follows: "Spawned by a swirl of cosmic dust and forged in elemental fire, the globe on whose familiar face we live spins towards destruction by its parent sun."

How Geological Time Is Measured

Face to face with the staggering figures mentioned above the question arises—how are these estimates arrived at? What evidence is there to justify these statements? The phrase time immemorial becomes real indeed when viewed in the light of these enormously long periods. How old is the earth is a question upon which philosophers have speculated all down the ages. As scientific thought developed various methods of computing the age of the earth have been considered.They have been based, for the most part, upon observations of the results of some natural process that has operated steadily upon or within the earth. A method that finds much favour nowadays has to do with radio-active substances that are dispersed throughout the rocks. It is this method which gives the long periods of time that scientists now consider necessary to bring about the geological features recognized to-day. These radio-active substances are commonly found in granites and pitchblende. It will be remembered that Madame Curie first discovered radium, one of these elements, in pitchblende from Bohemia.

The common property of radio-active elements is that they are continually losing part of their substance by giving off invisible radiations. During their subsequent disintegration the element changes to something different. Thus uranium breaks down through a series of changes into lead and helium. The rate of disintegration can be mathematically computed. By measuring carefully the relative proportions of these elements in a given rock, and knowing the rate of disintegration, it is possible to determine the time it took the original element to break down. This time would represent the approximate age of the rock in which the element was found. Accordingly, rocks of over 2,000 million years have

been determined. Other similar methods, employing different minerals, have been used and these tend to confirm the great ages to which reference has been made. Thus in the Keewatin district, south and east of Hudson Bay, an age determination of 2,550 million years is given for certain rocks; in the South African Transvaal ages up to 2,860 million years have been assigned.

Beginnings of Life

It has been postulated that about two thousand million years ago life came to the new-born world. At the outset it was in all probability only a single cell of protoplasm formed by the combination of hydrogen, oxygen, nitrogen, and carbon atoms by some natural but as yet unfathomed process. It is possible that the primary oceans, formed in the crustal depressions, provided a favourable medium for the existence and further development of this newly formed elemental substance, life. In the beginning it was not likely differentiated into plant or animal but was merely living matter capable of sustaining itself and of reproducing its kind. Later came the separation into one-celled plants and animals. From these lowly organisms developed, it is believed, the many and varied forms of life that are known to have existed through the ages. Since these very early creatures were soft and jelly-like, and of microscopic dimensions, they were incapable of becoming fossilized, and so their remains are not preserved. During the eons that followed, primitive multicellular organisms must have developed in the seas, but they, like their predecessors, were for the most part soft-bodied. When they died they fell to the sea-bottom and were soon destroyed. In due time, however, shellfish appeared. The shells could better resist the many hazards to which they were subjected, and so they stood a fair chance of being preserved, particularly if buried quickly in the muds or other sediments. However, in spite of the fact that shellfish must have been present in the later primary oceans, no undisputed fossils are found

Distribution of land and sea in Ordovician

in sediments older than the Cambrian period which began 500 million years ago.

Many theories have been advanced from time to time to account for the lack of direct evidence of life before the Cambrian. None is entirely satisfactory, but let us consider a few of the main assumptions:

1. That there were no organisms
2. That organisms were soft-bodied
3. That the record may not be accessible
4. That erosion took its toll and that metamorphism changed or destroyed the organic remains

With regard to the first assumption it may be stated that, in the opinion of those who have given thought to the subject, it is highly improbable that no life existed prior to the Cambrian, and so that thought may be dismissed.

The second assumption—that the bodies of organisms were not such as would render them capable of preservation, i.e., that they had no hard parts—warrants consideration.

Deficiency of calcium in the early seas might account for lack of shells or other investments, while an excess of acid might have destroyed any skeletal structures present. It is probable, however, that evolutionary development offers a more reasonable explanation. Life may have originated in the surface waters where simple unicellular plants found a favourable environment. With an abundance of plants present in these waters, animals depending upon them for existence might naturally evolve. Living and floating in this medium these animals would have no need for hard parts, in fact hard parts would be detrimental to their activity. To escape an ultimate crowding of this environment, some forms sought and found a new habitat on the sea-floor of the shallow coastal waters. Here sufficient food was available from the rain of dead and decaying organic matter from the surface waters. On the sea-floor, protection for some lay in a shelly armour whereas others depended rather upon motility. Thus some remained soft-bodied while others evolved an exoskeleton. It is likely that the evolution

of hard parts did not take place until late in time, hence the vast floating populations of earlier days went unrecorded.

Thirdly, that certain records of life are inaccessible is not impossible. Organisms with hard parts capable of preservation may have lived and been deposited in the sediments of seas outside our present land masses. All will agree that such rocks would lie far beyond our reach by any presently known technique.

Lastly, that erosion took its toll is most probable. Fossiliferous deposits left on what are now our continents by invading Precambrian seas must have suffered loss from time to time through vigorous erosion. Furthermore, volcanoes were very active in the early world and they may have been a potent factor in changing or destroying the record of otherwise available ancient life.

Nature's Calendar

It is an established fact that the deposition of sediments in prehistoric seas has given rise to most of the stratified rocks of to-day. Each group of rock strata represents a time which may be measured from hundreds of thousands to millions of years. The subdivisions of geological time or, more popularly speaking, of nature's calendar, are based upon the succession of these ancient sediments, which are separated by rhythmical interruptions or breaks in sedimentation.

In the time-chart represented on the frontispiece, an imaginary vertical cut through the rocks (for the most part sedimentary) of the earth's crust, from the oldest to the youngest, is shown. It is highly improbable that at any one place such a series of rocks would be found. However, by piecing together information obtained from various places in the world, it is possible to build up such a tabular arrangement. Frequent reference to this time-chart should be of great assistance to the reader in following the story as it proceeds. Already mention has been made of the basal units, namely, Cambrian and Precambrian.

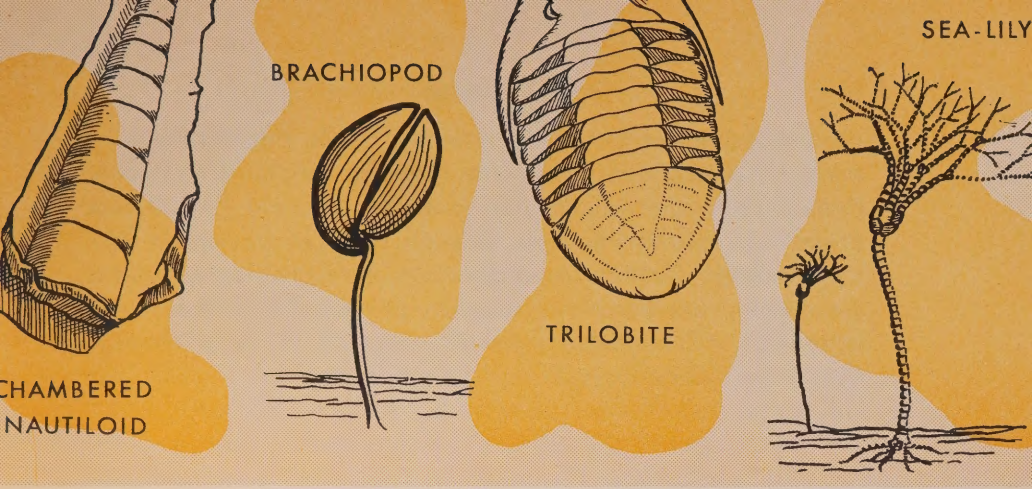
It will be noted that the largest subdivisions recognized are called eras, of which there are five in number. The ending -zoic, common to all five, comes from the Greek word meaning life. Thus the oldest era, *Archaeozoic,* means beginning of life; followed by *Proterozoic,* very little life; then *Palaeozoic,* ancient life; *Mesozoic,* middle life; and *Cenozoic,* recent life. These stages suggest the great changes in the development of life which will be outlined in this story.

The eras are divided into periods. Their names are derived mainly from European sources, owing to the fact that much of the early geological work was done on that continent. In many instances the period names are geographic in origin, for example, Cambrian is from Cambria, the old name for Wales and Devonian from Devon; but a few are descriptive terms, applicable to the rocks, such as Carboniferous, coal-bearing; and Cretaceous, meaning chalk.

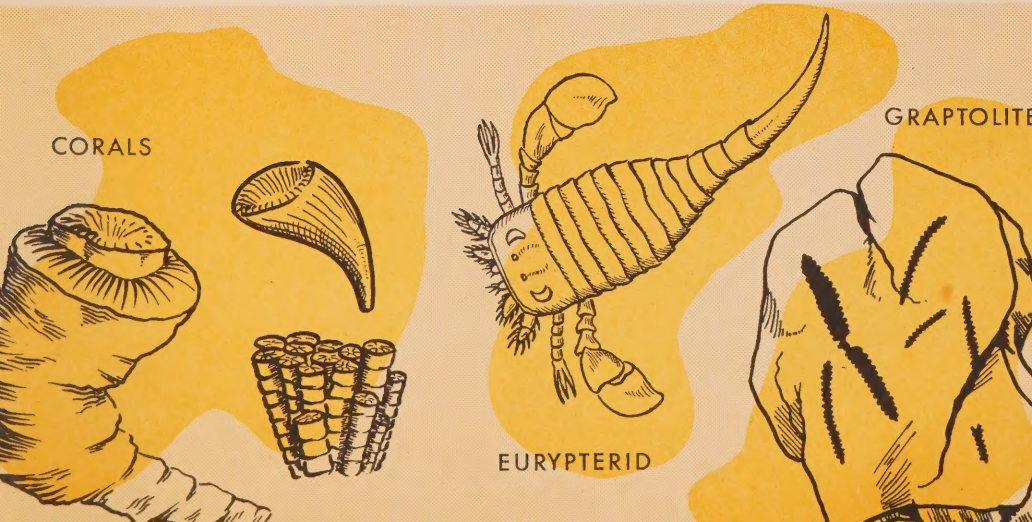
How Fossils Got in the Rocks

It has already been pointed out that life, though probably present in the Archaeozoic and Proterozoic, left behind no direct evidence of its existence. Another glance at the chart will show that these eras represent by far the greater part of the geological calendar. With the beginning of the Palaeozoic era, however, life in the seas was well established. Fossil-bearing rocks of the early Cambrian period conclusively prove this fact.

It may not be clear to some just how fossilized shells actually got in the rocks. In order to explain this phenomenon let us suppose that the continent of North America became depressed to the extent of about 600 feet. It would then be found that the oceanic waters of the eastern part of the continent would encroach slowly and appreciably upon the present land. Hudson Bay would be more extensive, the Gulf of St. Lawrence would be much expanded, the Atlantic and the Gulf of Mexico would flood larger



regions. Over the land areas thus submerged by marine waters, sediments in the form of muds, sands, and limy oozes would accumulate. In these sediments would be buried many of the bottom-dwelling shellfish such as corals, molluscs, and crustaceans, along with possibly a few teeth of sharks, bones of whales, and other marine life. If the continent were then uplifted and the oceans drained off, the sedimentary deposits, with their enclosed organic remains, would bear witness to this imaginary submergence. Just such submergences have occurred again and again in the past, leaving behind, in an orderly succession, their sediments



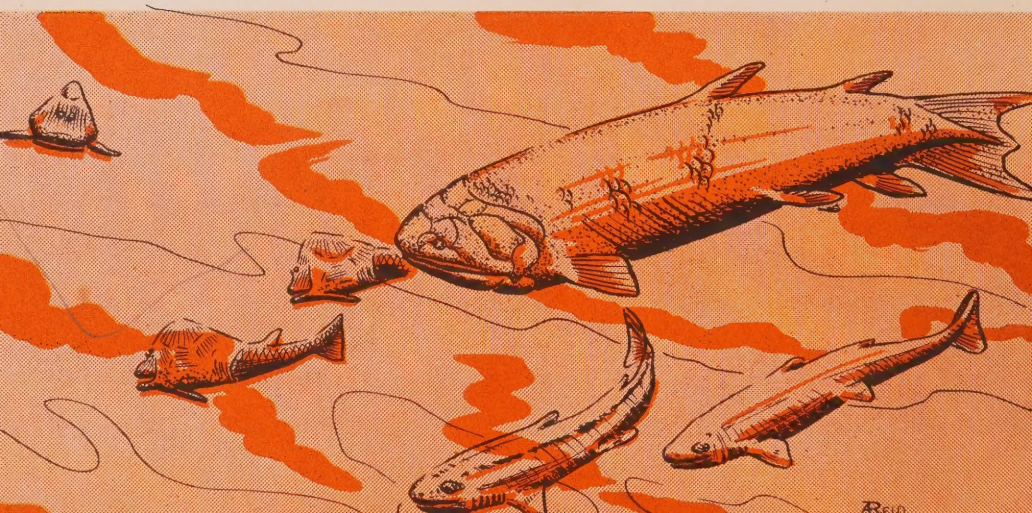
(now rocks) along with their entombed fossils. *Fossils thus serve to tell the time at which the rocks, in which they are found, were formed.* From successive records of this kind we can read as from a diary the history, in chronological order, of prehistoric life. Unfortunately, for various reasons many of the chapters and pages are missing, but from what remains preserved it is possible to determine, with almost unbelievable accuracy, the range through time of the main groups of animals and plants.

Early Fossil Types

During the first half of the Palaeozoic era, i.e. up to and including the Devonian, most of the life was confined to the sea. Invertebrates (animals without a backbone) and seaweeds constituted the dominant types. Outstanding among the animals were the trilobites, eurypterids, brachiopods, graptolites, crinoids (sea-lilies), corals, and chambered nautiloids.

Of these forms the trilobites, remotely related to the lobsters and crabs of to-day, and the eurypterids (sea scorpions) are now extinct. The graptolites, primitive floating creatures, drifted around the world in the oceanic waters before disappearing forever from the scene. They left behind flattened black, carbonaceous skeletons that often look like writing on the rocks. Of the

Devonian fishes



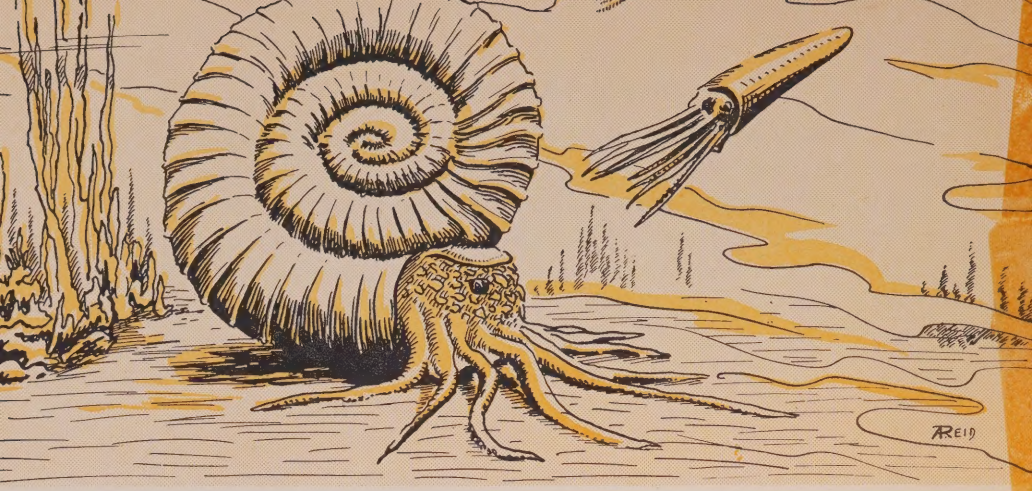
other groups mentioned the brachiopods, organisms with two protective shells, were more numerous than at any subsequent time in earth history, while the corals abounded for the first time in the Silurian and Devonian, the latter period being referred to as the Age of Corals. In these warm, clear waters corals formed great barrier reefs in which many different kinds were present, both of the solitary and colonial varieties. Such fossil reefs existed even in the Arctic region. Lastly, the chambered nautiloids, devil-fish of ,their day and now practically extinct, were likely the strongest and most predaceous creatures yet known. Some fossil nautiloids reach twelve feet (or more) in length.

Such organisms as these, together with many others, including unicellular animals and plants, flourished in countless numbers in the coastal waters of the prehistoric seas. Decomposition products of the bodies of these 'denizens of the deep' accumulated in vast quantities on the sea floors. Some of these accumulations constituted an initial stage in the development of the hydrocarbons which we now recognize as oil and gas.

Higher Animals and Plants Appear

During the Age of Corals strange fish-like, armour-plated creatures, as well as primitive sharks, lung fish, and ganoids appeared. Land plants made their first appearance about this same

Carboniferous scene



Ammonite and belemnite

time; they were of the spore-bearing variety and relatively simple in organization.

In the succeeding periods of the Palaeozoic still greater advances were made in both the plant and the animal world. Amphibians, derived from the lung fishes and ganoids of the Devonian, and represented to-day by frogs, toads, and salamanders, crawled about in vast swampy areas. Although some of these animals were no larger than modern examples of the amphibian class, others attained a length of six feet or more.

Among the primitive land plants huge horse-tails, giant club-mosses, and towering seed-ferns flourished in vast swamps throughout the world. Great dragonfly-like insects, some with a wing spread of nearly three feet, flitted in and out among the trees; cockroaches in great numbers, some six inches long, scurried over the ground; millepedes crawled sluggishly over the sodden logs.

When the trees died, they fell into the swamps and some were quickly covered over by the muddy waters, thus preventing their decay. As many millions of years passed, layers and layers of buried forest were changed into coal through pressure, heat, and other agencies. Much of the world's coal supply was thus formed.

From the foregoing account it will be noted that by the end of the Palaeozoic era life was well established on the land. In the three

hundred and fifty million years that had elapsed since fossils first appeared in profusion in the rock strata, by far the most fundamental changes had taken place in the organic world. Yet life on the whole was primitive as compared with what followed.

The Age of Reptiles

With the beginning of the Mesozoic era many of the old races of animals and plants had passed the peak of their development, and had declined or disappeared entirely from the earth. New races, however, higher in organization than their predecessors, did not fail to appear. And so it is not surprising to find the amphibians giving place to the reptiles, and spore-bearing plants being replaced gradually by the seed-bearers, among which conifers, cycads, and gingkos are significant. Among the invertebrates the ammonites and belemnites, related respectively to the present-day nautilus and squid, appeared, flourished, and died.

In spite of many new and interesting lineages, clearly traced by means of fossils, nevertheless the Reptiles, above all others, were the most spectacular creatures in the Mesozoic. They swam in the seas, they dominated the lands, and they flew through the air. Outstanding among the land reptiles were the dinosaurs (terrible lizards). These cold-blooded, egg-laying, stiff-jointed, hairless creatures were at this time the lords of creation. They ranged in size from small forms not larger than a fowl to huge forms a hundred feet long. Skeletons of dinosaurs have been found in Mesozoic rocks of all the continents, with the possible exception of Australia, but chiefly in Europe and North America. In Canada most of the splendid skeletons in the world-famous collection of the Royal Ontario Museum came from the Cretaceous rocks that now form the banks of the Red Deer River in southern Alberta. These rocks were formed in the brackish coastal waters of a shallow sea that covered Alberta in the above-mentioned period, from one hundred to fifty million years ago. Along the swampy

borders of this ancient sea, where deltas formed at the mouths of rivers draining into it, the dinosaurs wallowed in the muds or battled for supremacy in the more open spaces of the tangled jungles. When they died some individuals from these great primeval hordes were buried in the muddy sediments. Later the sea retreated and the sediments, now rocks, were left behind with their entombed treasures.

In a broad way the dinosaurs may be classified into two groups —plant-eaters and flesh-eaters. The character of the teeth and other skeletal structures, furnish evidence for such a subdivision. In the collection at the Royal Ontario Museum varied examples of each of these types may be seen.

Among the many kinds of plant-eaters the duckbills, named from the apparent resemblance to a duck's mouth, stand out preeminently. On an average these specimens are about 17 feet tall and from 25 to 30 feet long. They tend to be bipedal in habit, and they have a long tail. Their front limbs are relatively short; furthermore, there is evidence to support the belief that they were web-footed, thus indicating that they spent considerable time swimming about in the water, in all probability to escape their enemies. *Corythosaurus* is a common Alberta form.

Besides the duckbills there are the horned dinosaurs, a varied race of bulky quadrupeds. From one to three horns of many shapes and sizes bedecked the head, while a flanging, bony frill extended backwards over the neck.

Carnivorous and herbivorous dinosaurs

The flesh-eaters were fierce, swift-moving, bipedal animals with large heads and powerful, sharp teeth and claws. The front limbs were very small and were used probably for grasping the prey and tearing the flesh. The most spectacular of the flesh-eaters is *Tyrannosaurus rex*, the king of the tyrant lizards. Skeletons of these creatures measure as much as 47 feet long and 20 feet tall, with the head 4½ feet long and 3½ feet high, the jaws of which show conical teeth 6 inches long. A smaller form known as *Gorgosaurus* is typical of Alberta.

In spite of the world-wide distribution of the dinosaurs, their great numbers, and their extreme variation, they, like most of the previous dominant groups, in due time showed signs of decline and by the end of the Mesozoic they disappeared forever from the stage of history. Although speculation on the causes of extinction is dangerous, it would appear that many circumstances contributed to the disappearance of the dinosaurs. In the first place they, as a group, existed for a very long time, at least 150,000,000 years. During that time they became very closely adapted to their environment; any changes in that environment drastically affected the economy of their lives. Changes in that environment, among which different food and a cooler climate may be cited, tended to weaken the resistance of this once powerful and spectacular race. In addition, the rise of the mammals at this time contributed to their downfall. These small animals may have harried dinosaur nests, thus fewer eggs were hatched. The end was inevitable!

During the Jurassic period of this same middle era, the first bird appeared. Aside from possessing feathers it was little more than a glorified flying reptile. *Archaeopteryx* (meaning ancient feather), as this bird was called, possessed jaws in which reptilian-like teeth were well developed and numerous. The first specimen was nothing more than the imprint of a feather, the oldest known to science. It was unearthed in limestone quarries at Solenhofen in Bavaria in 1860. This limestone was deposited in a Jurassic lagoon. One month later a nearly entire individual was discovered at the same locality. This specimen may now be

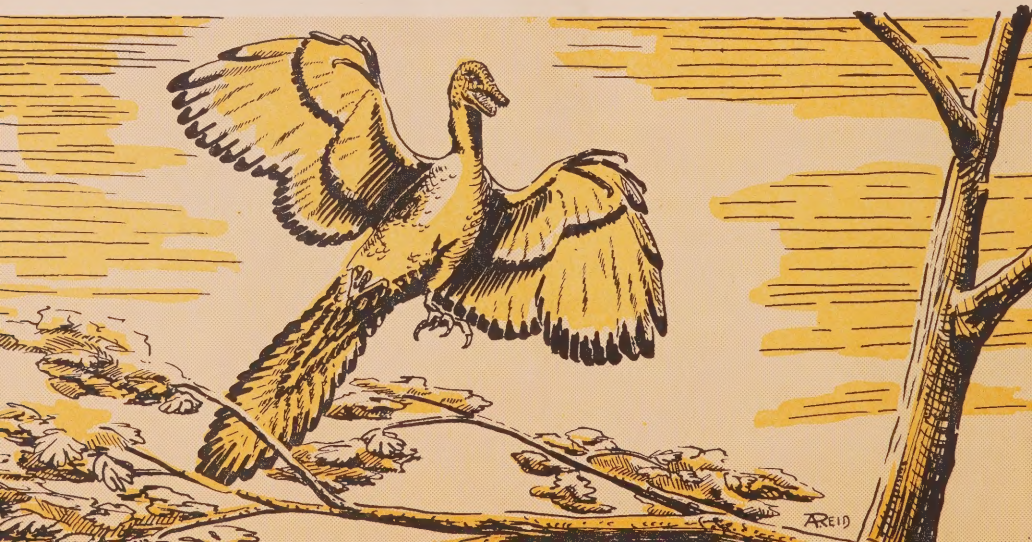
seen in the British Museum of Natural History. In 1877 a third specimen, the most complete yet known, was found in the same area. Although not an *Archaeopteryx,* it is closely related. These two fairly complete specimens and the one feather are the only authenticated remains of Jurassic birds that have been discovered up to the present time. Birds were probably numerous, however, but owing to their aerial habit their skeletons escaped preservation by falling in unfavourable spots for permanent burial. The birds in question, luckily for science, fell into a quiet lagoon, were quickly buried, and thus were preserved.

The Mammals Take Over

Towards the end of the Mesozoic the earth was greatly changed. The vast seas that had formerly covered the interior of the continents withdrew; great mountain chains arose, including the Rockies in North America; and the courses of ocean currents were altered. It is not surprising to find new animals and plants, stimulated by such stupendous geographic changes, replacing those that flourished in the older world.

In the plant kingdom trees appeared that bore conspicuous flowers, shed their leaves, and produced fruits. They soon became the characteristic plants replacing, in the economy of nature, the

Jurassic toothed bird, *Archaeopteryx*



evergreens, the gingkos, and the cycads, the outstanding Mesozoic types.

Early in the Cenozoic, in the Tertiary period, grasses appeared on the central plains of the continent. Such plants influenced in no small measure the lives of the higher animals that were developing at this time, namely, the mammals. They found vegetable food in greater abundance than had ever before existed. Since they had no reptiles to fear other than crocodiles, snakes, and turtles, it is little wonder that they began to thrive in great variety and abundance. Soon they were to become the dominant creatures of the earth. Although a rich fossil record of mammalian life is known, it is by no means proportionate to the great numbers that have existed since the beginning of the Cenozoic. It must be realized that in the past, as now, most mammals lived upon the land. When they died their remains lay for the most part in exposed places where they were either dismembered and devoured by other animals or destroyed by eroding forces, so that no record was left of their existence. Some few were quickly buried by nature in swamps, in lake beds, in ice, in asphaltic beds, or in some other favourable medium, and were thus preserved to posterity.

The oldest Cenozoic mammals were mostly small, very generalized varieties. Among them there were both plant-eaters and flesh-eaters, exhibiting more varied and complex teeth than the reptiles. None of these older mammals could be recognized at first sight as being directly related to animals that live to-day. To illustrate, let us take a mammal familiar to all, the horse. The ancestral type, which dates back some fifty millions of years, was a small, probably five-toed animal, not larger than a medium-sized dog, with low-crowned teeth for browsing. Through a regular series of fossil forms, from the beginning of the Cenozoic to the Recent, successive changes in the ancestry of the horse may be traced. These changes involve increase in size, loss of toes, and formation of the middle toe into the hoof, together with lengthening of the crown of the tooth as a more efficient structure to accompany the gradually developing grazing habit.

Early Cenozoic horse

Similar changes may be noted in the elephant tribe, the latest extinct types being the Mastodon and Woolly Mammoth of the Great Ice Age, which the more northerly countries of the world experienced during the last million years, a mere yesterday in geological time. Teeth and tusks (a modified incisor) of these animals are commonly found in the superficial deposits from coast to coast in the Dominion and as far north as Alaska. Occasionally nearly complete skeletons are unearthed. Frozen carcasses in the Siberian tundras, with their shaggy coats preserved, attest to their survival during the closing years of the Ice Age.

Developing along with these more familiar creatures, and constituting part of Nature's pageantry, were countless numbers of mammals, many extremely bizarre in appearance—some large and bulky, others small yet highly specialized, that dropped out of the long procession of life, leaving behind no direct descendants.

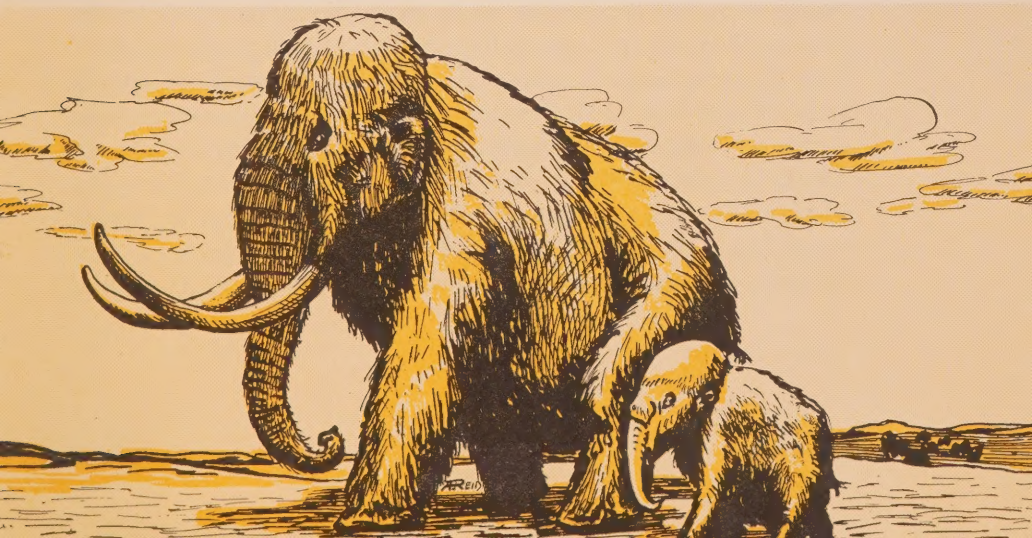
Man Inherits the Earth

Fossil remains of humans, the highest of all the mammals, are exceedingly rare. Many factors have combined to deprive us of a clear record of man's rise to his present position of dominance over the other creatures of the earth. Ancestral man, for instance,

probably lived in well-wooded regions where the humic acids destroyed their skeletal remains. Furthermore, being more intelligent than the lower animals man probably avoided, as far as possible, swamps or other dangerous places, where natural burial in accumulating sediments would make preservation more likely. In addition, it is possible that many bodies were cremated or otherwise destroyed in the practice of primitive tribal burial rites.

In spite of such unfortunate circumstances the ancestors of modern man can be traced back a million years or more, that is to say, through the late Cenozoic into the Pleistocene period. Probably the oldest and the most primitive of all the actual fossil remains of man's direct ancestors is *Pithecanthropus erectus* found in Java in 1891. The skull and a few other bones are all that is known of this particular race. Another closely related type is *Sinanthropus pekingensis* found near Peking in 1928. In the decade that followed about forty individuals of this species were uncovered, the fossils consisting mostly of skulls. It would seem that this species and *Pithecanthropus erectus* represent the same stage of human evolution. These two races flourished during the second Interglacial period of Europe (600,000 B.C.) when the ice cap in Europe and Asia had retreated northward, leaving in the more southerly regions a genial climate which made living conditions more favourable for primitive man.

Woolly mammoth



To the second Interglacial also belong the human remains of *Palaeanthropus heidelbergensis,* found near Heidelberg in Germany in 1907. The jaw and teeth of this form are so different from other finds that it is believed to represent another contemporary human race. These three races represent early Paleolithic (Old Stone Age) cultures.

As we approach the third Interglacial period, which brings us to about 100,000 B.C., Neandertal man, *Homo neandertalensis,* makes his appearance in great numbers over a wide geographical area. The original discovery, made in 1857, came from Neander Valley, near Düsseldorf in Germany. Since that time skeletal remains have been uncovered in caves and rock shelters in many places in Western Europe, in the Crimea, in Palestine, and elsewhere. Their somewhat improved stone implements (axes, scrapers, and flint-tipped spears) are even more widely distributed, having been found in Asia Minor and farther east, as well as in South Africa. The skeleton found within recent years at Broken Hill in Rhodesia is considered to be of Neandertaloid stock.

Neandertal race seems to have been replaced rather suddenly by a much finer human type of early *Homo sapiens,* known as the Cro-Magnon race. This race flourished during the fourth glacial period (55,000 to 15,000 B.C.). The original discovery of five individuals was from the rock shelter of Cro-Magnon in the French village of Les Eyzies. These people were tall and straight, with long legs and freer in their movements than the Neandertals or any other previously discovered races. They had superior intellect and fashioned better implements of stone and bone than their predecessors. They appear, also, to have had an amazing artistic ability. That Cro-Magnon man was familiar with such prehistoric animals as the Woolly Mammoth is evidenced by paintings of these creatures on the walls of certain caverns in France and southern Spain. An artistic development was, therefore, one of his accomplishments.

As the ice sheet withdrew, the climate moderated and the Recent epoch began, about 15,000 years (or more) ago. Neolithic man (New Stone Age), with his progressively higher cultures, quickly spread

Cro-Magnon man, his art, and his home

in all directions from a probable place of origination in southern Europe. With the spread of this early culture, modern civilization is thought to have begun. More permanent dwellings replaced earlier casual cave habitations; community life was started; animals were domesticated; and the art of making pottery was gradually developed. From that time on history deals with modern man and our story of ancient life ends.

Early Man in North America

Before closing this short account of early man in the Old World let us turn our attention for a moment to North America. Who were our ancestors and where did they come from?

Until very recently the presence of early man in North America was recognized only by artifacts, such as weapon tips chipped from stone and other implements. Caves in New Mexico have proved for some time to be one of the most fruitful exploration sites. But in 1953 in an excavation near Midland, Texas, a human skull and extinct animal bones were found that have been proved by scientific tests to be between 12,000 and 20,000 years old. These estimates are the oldest yet given for actual remains of man in the

New World. Successive cultural periods also have been discovered in these southern regions the latest being dated at 8,000 years. Some archaeologists believe that during the late Palaeolithic period Cro-Magnon man migrated to North America from Asia by way of Behring Strait. No record of the race has been found in these northern regions, probably because the glaciers which covered that part of the country destroyed their dwelling places. In due time, however, descendants of these early migrants reached the southern states where they found habitable caverns and rock shelters (similar to those in Europe) which have been preserved. Some of these buried shelters are now being discovered together with their long hidden records. These early settlers may be the progenitors of our North American Indian with whom they appear to be physically similar.

Now What?

In glancing thus, though ever so hastily, over a few pages in Nature's intensely interesting and highly dramatic diary, a marvellous record of the progress of living things is revealed; such a record cannot fail to stir the imagination and to provoke thought. It clearly demonstrates that great groups of animals have come and gone as the scenes changed from age to age. Each group in turn rose to a maximum, passed over the peak of domination, and then declined or vanished completely, to be succeeded by another which from a position of insignificance and obscurity gradually ascended the curve of importance until it became the dominant race. It might be noted that each oncoming race was of higher and more complex biological organization than the one it replaced, though in the offset it may have been obscure and of no apparent significance. In all cases of the dominance of an animal group,

once it was lost, it was gone forever; not one of the ruling dynasties of antiquity ever regained its former position in the economy of Nature.

Similar observations may be made in the history of mankind. From the earliest time of which written records are available it will be remembered that tribe after tribe, dynasty after dynasty, nation after nation have risen from a position of unimportance to a triumphal and golden age. Such a period invariably preceded its ultimate, and apparently inevitable, decline. But each ruling group or empire, whatever the case may be, seems to have left some permanent contribution to civilization which will not perish. Thus we see that palaeontological history is to a degree corroborated in the history of mankind.

By tracing in this manner the history of past life a possible explanation of the present may be found. Furthermore, in observing the orderly progress of living things very early in time down to our own day, we may catch a glimpse, faint and imperfect though it may be, of future geological trends.

Man will in all probability continue his control of the earth for milleniums to come. Observed facts, of course, indicate that the human race is gradually changing physically.

Accompanying these slowly developing physical changes, we are well aware of an acceleration of thought processes, responsible in no small measure for the 'social revolution' mankind is now experiencing. Along with modifications of body further modifications in the mind will most surely continue. Like the overspecialization of structure which attended the fall of fossil dynasties, so overspecialization of the mental fabric, resulting in ultra-intelligence, may lead to an ultimate downfall of future (or even the present) races. By unleashing more and more of the stupendous forces of Nature in the Atomic Age man might conceivably bring about his own destruction. While this possibility exists there is little likelihood of the complete destruction of the human race in the near geological future. If and when the sun burns itself out in a series of final old age convulsions (several billion years hence)

life, should such exist, will no doubt be destroyed. But the sun is relatively young and will probably be a life-giving force for at least another 500 million years. At this remote time the highest forms of life that we now know may have evolved to such a state that some further medium for its existence will have been sought and found. But let us leave that speculation for just a moment and again briefly consider recognized facts. From our earlier discussion it is evident that there has been a gradual passing from a physical to an intellectual development which gives to man his present dominance over the creatures of the earth. Man in his pride of intellect congratulates himself on the fact that at the culmination of 500 million years of life processes, brain has at last achieved superiority over brawn. He can conceive of no other factors or forces in the human make-up that could challenge the controlling influence of the physical or present mental state. But could the earliest cave-man, depending on muscles for his dominance, conceive of a puny descendant in whom mental development would take precedence over the non-intellectual physical giant? Could the trilobite, grubbing over the sea floor, conceive of a creature with a bony skeleton, the fish, darting at will through the great ranges of the ocean depths? Could that same fish, lord of his ocean environment, comprehend a form of life that could live in a medium of which he knew nothing, the air above his ocean world OR the land of which he was totally unaware? Could the amphibian predict the mighty dinosaur, or the primitive egg-sucking mammal, man? The answer to these questions is almost surely, No! Carrying then this line of thought a little farther, man, at the present time, knowing only brawn and brain as controlling influences in his life, finds it difficult to predict the future of his race except in terms of these two forces. Nevertheless, there are at least some in our race who have confidence in still another force than the physical or intellectual—the psychic or spiritual, vague inklings of which are accepted by some and scoffed at by others according to their mental attitude or to the degree of thought which they have given to the subject.

Should the trend be towards the psychic, then a further life medium must be postulated for man's highest and progressively developing attribute, the mind. The cosmic ether characterized by elements and forces as yet unknown, all awaiting discovery, may provide that medium. With this postulation an entirely new set of biologic changes might be initiated and we would then have begun still another long and prodigious journey towards the unrevealed goal.